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Benthic foraminiferal monitoring revealed environmental triggers of faunal changes

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Foraminiferal monitoring receives a growing attention for investigations of the response to global climatic changes and assessments of the anthropogenic impact on marine environments. Decadal or longer time series depicting climatic and environmental variability are very rare. The few existing European marine long-term monitoring projects of governmental authorities mainly consider plankton composition, seawater chemistry, and hydrography.

Attempts to monitor benthic foraminiferal assemblage dynamics face the lack of continuous funding since monitoring is still deemed as a non-scientific pursuit in academia, because it is missing a sound hypothesis to be tested. A way to overcome these objections to long-term monitoring studies is to combine them with field and laboratory courses for undergraduate students, as for instance the field course 'Foraminiferen im Schleswig-Holsteinischen Wattenmeer' in the Master of Geoscience curriculum at the Christian-Albrechts Universität Kiel. This course was held every year at the same place at Bottsand coastal lagoon, western Baltic Sea (Fig. 8). Quality control was ensured by the lecturers, consistency of methodology was given by the course subjects, and there was sufficient manpower to work up all the samples in due time. Supplementary environmental data were obtained with commercially available, budget data loggers.

The faunal and environmental data accumulating over the years contain secret treasures waiting to be unveiled. The recent paper published in volume 37 of the Journal of Micropalaeontology described benthic

Figure 8: The author sampling Bottsand lagoonal sediment for benthic foraminiferal monitoring, 16 November 2012 (photograph: Maike Nicolai, GEOMAR).

foraminiferal dynamics from Bottsand coastal lagoon, which has been monitored annually since 2003, and which has been accomplished by monitoring the hydrography of the lagoon two months before sampling since 2012. To my surprise, *Elphidium incertum*, a common species of the Baltic deep-water fauna and adapted to high salinities, colonized the lagoon in 2016, most likely during a period of salinities >19 units and average temperatures of 18 °C in early autumn. The high salinities probably have triggered their germination from displaced propagules (tiny unilocular resting stages of benthic Foraminifera) in the lagoonal bottom sediment. Such a bloom initiated from propagules has not been observed in nature before, neither has it been coupled with instrumental data revealing the environmental trigger of their germination. The *E. incertum* population showed densities higher by an order of magnitude than those of the other, indigenous species. Another surprise was that *E. incertum* survived extended periods of brackish conditions in fall 2017 with low abundances.

The results of the monitoring study revealed an immediate faunal re-

sponse to environmental changes, and we even may envisage response time constraints. The populations sustained if the new conditions prevailed for a period longer than the growth time, about two weeks in the present case, and unfavourable conditions do not last longer than the generation on time of species concerned, probably 3 to 6 months as implied by Wefer (1976). The remarkably high resilience of near-shore Foraminifera imposed caveats on the interpretation of palaeo-records. Can we be sure that faunal changes truly indicate switches to new ecosystems or do they rather mirror the excess of certain threshold values? A continuation of monitoring at Bottsand lagoon and more time series of benthic foraminiferal dynamics, environmental, and ecosystem properties are needed to answer this question.

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